BEFORE THE
FEDERAL COMMUNICATIONS COMMISSION
Washington, D.C.

ORIGINAL FILE

In the Matter of	)	
Redevelopment of Spectrum to Encourage Innovation in the Use of New Telecommunications Technologies	)	ET Docket No. 92-9

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REPLY COMMENTS OF
CORPORATE TECHNOLOGY PARTNERS

CORPORATE TECHNOLOGY PARTNERS

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SUMMARY

Corporate Technology Partners ("CTP") is a leading proponent of a frequency sharing approach to accommodating the spectrum needs of emerging PCS technologies. CTP has specifically proposed the utilization of an interference sensing CDMA ("ISCDMA") approach to accommodating PCS spectrum needs in the 1850-1990 MHz band facilitating frequency sharing with fixed microwave users.

CTP believes that the capabilities of frequency sharing approaches to meeting spectrum allocation difficulties posed in this proceeding have not been adequately addressed in the record. Accordingly, CTP hereby files these reply comments demonstrating that the Commission should include a careful assessment of frequency sharing PCS technologies in this proceeding. As detailed herein, such innovative sharing techniques, including ISCDMA, promise to assist substantially the Commission's resolution of the difficult spectrum allocation issues it has raised in this proceeding regarding accommodating both new and existing uses of the 1.8 to 2.2 GHz band.

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REPLY COMMENTS OF
<u>CORPORATE TECHNOLOGY PARTNERS</u>

Corporate Technology Partners ("CTP") files this reply in response to the comments filed in the Commission's proceeding concerning spectrum for emerging technologies, ET Docket No. 92-9. In CTP's view, in focusing on the need for spectrum redevelopment for new wireless personal communications services ("PCS"), many of the commenters have failed to consider adequately technologies which would allow frequency sharing with fixed microwave users in the 1850-1990 MHz band. CTP is a proponent of one such technology, interference sensing CDMA ("ISCDMA"), which would not only allow frequency sharing between PCS and fixed microwave, but also would allow PCS providers to co-exist with fixed microwave users on a secondary basis under many conditions.[1/] To make efficient spectrum allocation decisions for emerging PCS technologies, CTP believes that the Commission should carefully consider the advantages of ISCDMA, because it would meet needs of current fixed microwave users while permitting future PCS users. CTP is therefore filing these reply comments to highlight the need for the Commission to consider the many advantages of frequency sharing techniques -- including ISCDMA -- in this proceeding.

[1/]CTP's Pioneer's Preference request (File No. PP-51), filed in General Docket No. 90-314, describes many of the details of this technology and frequency sharing capability.

ISCDMA IS THE BEST FREQUENCY ALLOCATION APPROACH FOR PCS

CTP believes strongly that the best approach to gain necessary frequency for PCS while preserving a maximum amount of flexibility for existing spectrum users involves interference sensing of fixed microwave transmissions, dynamic channel allocation to non-interfering frequencies and frequency agility to allow PCS handsets and base stations to be freely moved around the U.S. The advantages of interference sensing include increased capacity, certainty of protection for fixed microwave users and regulatory simplicity. *See* Exhibit 1 attached hereto. The greatest advantage of ISCDMA is that it would allow introduction of PCS without need to move current fixed microwave users. In fact, in most cases PCS could share with fixed microwave on a secondary user basis. Thus, CTP believes that this technology would significantly reduce the need for the Commission to focus on complex negotiation procedures between existing spectrum users in the bands between 1.85 and 2.2 GHz and the proponents of new PCS technology.

Conceptually, the advantages of employing a technology which automatically adjusts to avoid interference to fixed microwave transmission and avoids the need to move current fixed microwave users are obvious. For purposes of practically considering this technology as a viable solution to the spectrum shortage issues discussed by numerous parties in this proceeding, however, two questions have to be addressed: Is interference sensing in fact workable? Does interference sensing add unnecessary cost and complexity? As discussed below, CTP submits that interference sensing is workable, efficient and cost-effective. Accordingly, CTP urges the Commission to weigh the capabilities of ISCDMA carefully in assessing the need for spectrum for emerging PCS technologies. CTP believes that study of innovative frequency sharing approaches is a key component of the Commission's ability to resolve the difficult PCS spectrum allocation issues it is facing in this proceeding.

I. ISCDMA is a workable technology.

CTP has retained an outside consulting firm, TSR Technologies, Inc., to review interference sensing technology and provide independent comment to the Commission to assist the agency's study of this technology. TSR Technologies is associated with Virginia Tech and has provided consulting services to Telesis Laboratories, Inc. on propagation modeling and also to American Personal Communications ("APC"). When this report is ready, TSR Technologies intends to file it with the Commission.

Second, CTP has carefully reviewed all comments regarding workability of interference sensing filed with the Commission in General Docket No. 90-314 including new information made available through the most recent filings and related materials. These filings demonstrate that many participants in General Docket No. 90-314 are pursuing some form of interference sensing as a chosen method for narrow channel frequency sharing with fixed microwave and have on-going work confirming the validity of interference sensing. In light of these developments, CTP believes that interference sensing technologies should not be overlooked by the Commission in this proceeding. CTP submits that such technology advancements facilitating sharing could substantially aid the Commission's setting of timeframes and priorities for accommodating the spectrum needs of new PCS technologies.

General Workability. For interference sensing PCS to work correctly, it must protect fixed microwave users from PCS interference. Interference sensing thresholds must be set so that the summed interference on a particular PCS channel does not create detectable interference to fixed microwave users.

This analysis is the same whether one considers CT2, time division multiple access ("TDMA") or code division multiple access ("CDMA") technologies.[2] First, interference of PCS to fixed microwave has to be calibrated on a channel which will be the potentially interfering PCS channel into the fixed microwave transmission. Then, this calibration must be turned around so that it is understood at what point detected interference to the base station or handset from fixed microwave translates to potential interference in return to the fixed microwave transmission from the PCS transmission. Finally, thresholds have to be set in the base station and handset so that upon detecting a certain level of microwave interference which translates to detectable interference to the fixed microwave channel, the channel is rejected as unusable.

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[2] The original approach developed by CTP along with Bell Northern Research ("BNR") was for interference sensing frequency sharing of CT2 with fixed microwave transmission. CTP and Northern Telecom named this approach PCI (Personal Communications Integrator). "Integrator" refers to the ability to share with (*i.e.*, integrate with) fixed microwave transmissions.

CTP extended the same basic approach developed with BNR to CDMA. Rather than call it Integrator CDMA, CTP has called it interference sensing CDMA (ISCDMA) to refer to a basic ingredient of the approach. The Integrator or interference sensing approach is, however, not dependent upon choice of radio modulation technology. It would apply to any narrow channel modulation technology, Bellcore defined TDMA, DECT, CT2 and, of course, narrow channel CDMA.

CTP's choice of narrow channel CDMA for interference sensing PCS rather than CT2 was dictated solely by CTP's belief in the greater capacity of CDMA over CT2 in frequency sharing with fixed microwave. Even more important, CTP became concerned about the number of base stations required in use of CT2 to achieve adequate coverage. This was based on CTP's market research in the San Francisco Bay Area. The equipment to test interference sensing CT2 (i.e., PCI) will be available in the Fall of 1992 and could be introduced into the market by mid-1993.

This is accomplished by requiring the PCS system to always use the "best" channel(s) in terms of freedom from interference.[3] These channel(s) are selected from among the group of channels meeting pre-set useability thresholds regarding freedom from interference to fixed microwave.

Analysis of the absolute level of potential interference to fixed microwave from each PCS channel would be a complex and costly task. Analysis of absolute interference levels is not advocated by CTP, or to CTP's knowledge by any of the other companies such as Bellcore, Southwestern Bell, and APC which are now advocating interference sensing as part of their PCS approaches. What makes interference sensing workable is introduction of a system for measuring interference in relative terms rather than absolute terms. As a threshold matter, PCS channels obviously interfering with fixed microwave at the base station are blocked from use in the cell.[4] Then remaining useable channels are scanned for interference, and the ID designations of the best channels (in terms of lowest interference) are transmitted to the subscriber terminal. The subscriber terminal then scans these channels deemed best from the base station end of the transmission to determine which is best from subscriber terminal end of the transmission; and the channel eventually used is the one best (i.e., lowest interference) at both base station and subscriber terminal ends of the transmission.

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[3] *See* the CTP/BNR patent application, filed as Exhibit B to CTP's pioneer's preference request (File No. PP-51), and discussion in related documents filed by CTP, BNR and Northern Telecom with the Commission in the Fall of 1990.

[4] *See* page 9 of the CTP/BNR patent application attached as Exhibit B to CTP's pioneer's preference filing (File No. PP-51). This initial blocking out of interfering channels and then scanning for interference on remaining channels is also part of the APC FAST system.

Similarly, Exhibit 1 sets forth a procedure whereby the best transmission channel is selected in terms of lowest interference in a CDMA system. This is achieved through an initial registration, idle handoff, soft handoff and hard handoff to the channel with the best associated pilot channel. Assuming that the base station and subscriber terminal are required to choose the channel that is best in terms of freedom from interference, and if in addition general thresholds are set so that at certain detected interference levels PCS channels are rejected by the base station or handset, the result will be protection of fixed microwave from PCS transmission interference.[5/]

There is to date no empirical proof of the correctness of this assumption because no one has had sufficient PCS equipment available to do adequate testing of interference sensing PCS with fixed microwave. However, validation can be obtained from:

- The work of BNR and Northern Telecom supporting interference sensing. In November 1990, Northern Telecom presented interference sensing to the Commission as a workable technology in the form of PCI.[6/] Further, in numerous additional filings with the Commission BNR and/or Northern Telecom (along with CTP) stated to the Commission that interference sensing would work. This includes Exhibit C to CTP's pioneer's preference

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[5/]It is not enough to have the best channels selected without also having minimum thresholds set, because in a microwave environment with substantial fixed microwave, a "best" channel could in fact still be an interfering channel. Exhibit 1 attached hereto advocates testing to ensure Qualcomm pilot channels in fact become unusable at a threshold below which interference to fixed microwave could occur.

[6/]A copy of the Northern Telecom presentation to the Commission is attached as Exhibit D to CTP's pioneer's preference filing.

request and Northern Telecom's October 1990 filing of extensive comments to the Commission's NOI in General Docket No. 90-314.

- The more recent work of Bellcore. The latest Bellcore FA on PCS dated June 1992 has just become available. The FA does not specifically address frequency sharing with fixed microwave. However, it describes a PCS technology which operates very similarly to the CTP/BNR technology described in the patent application. Best channels are to be selected as transmission channels based on signal power. This measurement of interference is to be done from the base station on all forward channels between 2:00 a.m. and 4:00 a.m. each day when channel power can be temporarily interrupted to allow signal power measurement. Correspondingly from the subscriber terminal, selection of the best channel would be part of the demodulation process. The Bellcore PCS receiver apparently does interference measurements based on two pieces of information: the Received Signal Strength Indicator (RSSI) and a separate measurement relating to the ratio of signal to dispersion plus noise.

  There are differences in the Bellcore approach from the CTP/BNR approach. Bellcore transmission is FDD whereas CTP/BNR originally applied its technology to CT2, which is TDD.[7] Bellcore would scan all forward channels from the base station once a day, whereas as set out in the CTP/BNR patent application, CTP would initially exclude obviously

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[7]The CTP/BNR patent application is not limited to TDD. Later CTP work applied equally to TDD and FDD transmissions.

interfering channels and scan only remaining channels from the base station. However, the Bellcore approach appears to be very similar to the CTP/BNR approach. The key in both cases is to deal with interference not in absolute terms but in relative terms. Like the CTP/BNR approach, the Bellcore approach requires the system to use the "best" channel in terms of lowest perceived interference (low perceived power, freedom from noise).

While the Bellcore FA does not specifically address sharing with fixed microwave, it is CTP's understanding that the co-channel interference sensing capability of the Bellcore technology will be developed for interference sensing of fixed microwave transmissions. Specifically, the scanning from base stations in the 2:00 a.m. - 4:00 a.m. time slot will evaluate all interference conditions in making channel selections, including fixed microwave. Similarly, the interference sensing capabilities of the Bellcore PCS subscriber terminals in terms of selection of best channels will be evaluated in a fixed microwave environment.

- Work of other pioneer's preference applicants. Other pioneer's preference applicants have proposed some form of interference sensing and presumably have concluded it works. This includes in particular APC with its FAST approach and Southwestern Bell with its I-MAS approach. It is noteworthy that neither of these two pioneer's preference applicants, the applicants most familiar of all applicants with interference sensing, have challenged the workability of CTP's interference sensing approach. Rather, APC has disputed with CTP as to who invented interference sensing first.

- The work of narrow channel CDMA manufacturers. None of the three pioneer's preference applicants which know narrow channel CDMA best, Qualcomm Incorporated (File No. PP-68), Omnipoint Corporation (File No. PP-59), and Cylink Corporation (File No. PP-42) have expressed doubts regarding the workability of interference sensing in CDMA. Indeed, Qualcomm and Omnipoint proposed narrow channel CDMA approaches using frequency agility/dynamic channel allocation and implied elements of interference sensing. Cylink also proposed a dynamic channel allocation approach, but in the alternative to an exclusion zone approach.

EDD vs. TDD. In a fixed microwave environment TDD is to some extent a more accommodating approach. With TDD transmission there need not be concern for the problem of, for example, a PCS handset detecting no interference on a PCS forward channel it is monitoring and so transmitting on an FDD offset PCS reverse channel in interfering condition to a fixed microwave receiver. On the other hand, there is the distant transmitter problem mentioned in attached Exhibit 1. Assuming a microwave transmitter 30 or more miles away and the corresponding microwave receiver near in geography to the PCS subscriber terminal, a question arises as to whether the subscriber terminal will "hear" the microwave transmitter sufficiently strongly when operating on the same frequency. If not, the channel may not be rejected and there is danger of the subscriber terminal broadcasting into the nearby microwave receiver.

Under the CTP solution (and CTP/BNR patent application) the subscriber terminal does not have to "hear" the distant transmission strongly to reject the channel. The subscriber terminal will seek out the "best" channel in terms of power and freedom from noise; it will dismiss the interfering channel, not because of strong interference, but because it is not the best channel.

The advantage of FDD over TDD is that to some extent FDD answers the distant transmitter problem. Assume that the FDD PCS transmission is offset exactly the same as the fixed microwave transmission, nominally 80 MHz. Under these circumstances, if the PCS subscriber terminal does not adequately hear the fixed microwave interference on the forward channel, and thus allows transmission to occur on the reverse channel, at least there is some margin of protection to the fixed microwave receiver. This receiver is also 30 plus miles away (on the 80 MHz offset channel). An 80 MHz offset approach is advanced as one possibility for FDD interference sensing. *See* attached Exhibit 1.

The problem is that in certain cities microwave is not universally offset at the standard 80 MHz.[8] Possible answers to the non-standard microwave problem include:

- Require all present microwave users to move to 80 MHz offset. This would be better than moving microwave users entirely off parts of the 1850 - 1990 MHz Band. However, it is CTP's intent that ISCDMA allow sharing with present fixed microwave users and not require relocation even within

[8] Obviously the 80 MHz FDD PCS offset solution could be introduced for cities where all, or at least almost all, microwave is offset 80 MHz. Most cities fit this pattern. However, CTP is investigating a universal solution for ISCDMA which will allow nationwide roaming.

the 1850-1990 MHz band. Further, some "one way" microwave exists which would not be handled by requiring universal 80 MHz offset.

- Set FDD PCS with an 80 MHz offset and use beacons to protect microwave receivers which do not conform to the 80 MHz offset standard or are for one way transmissions. This would mean that with respect to each non-standard microwave receiver for a frequency not blocked out for the entire cell,[9] a beacon would be installed in the area of potential interference. This beacon would be offset 80 MHz from the receiving frequency of the microwave receiver. The subscriber terminal would detect the beacon on the forward channel (in interference sensing) and accordingly block out transmission on the 80 MHz offset reverse channel which could interfere with the microwave receiver.[10] The beacon approach may seem cumbersome, but in terms of complexity and cost, has potential advantages, particularly as in much of the country fixed microwave is offset the standard 80 MHz. Of course, beacons would have to be screened to prevent interference into fixed microwave receivers occurring from the beacons themselves.

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[9] As mentioned above, CTP's technology involves blocking from use in the cell all frequencies which at base station site are clearly interfered with by forward or reverse channels. Interference sensing is then used at base station and subscriber terminal regarding remaining channels.

[10] In accordance with CTP's technology, in other parts of the cell where the reverse channel would not interfere with the microwave receiver, the beacon would not be detected by the subscriber terminal on the forward channel. There the reverse channel would be authorized for transmission, resulting in creased capacity in the cell versus exclusion approaches which block out all channels from PCS use that might interfere anywhere in the cell.

- Add interference sensing to reverse channels. In attached Exhibit 1, a frequency sharing approach is described using interference sensing on forward channel pilot channels. Interference sensing could be added on reverse channels with subscriber terminal monitoring of reverse channels before transmission. If the reverse channel is flawed by interference (as determined by analysis of power and noise), the subscriber terminal would reject the reverse channel and scan for another pilot channel. The negative of this approach is that it adds further complexity and cost to the subscriber terminal (a separate receiver, input circuit and analysis circuitry).
- Referring to attached Exhibit 1, repress pilot channels on all PCS frequencies which are offset 80 MHz from non standard microwave receivers[11] where such microwave receivers would be interfered with by subscriber terminals in any part of the cell. The result would be some capacity loss from the ideal under CTP's ISCDMA approach. For microwave transmissions set up in standard, 80 MHz offset, CTP's interference sensing approach would continue to provide additional capacity in the particular city. PCS reverse channels would be useable as non-interfering in some parts of cells but not others, to the extent that standard 80 MHz microwave offset is employed in the city. And though capacity would be lost wherever non-standard microwave receiver offset

[11]Microwave receivers that are offset other than 80 MHz from microwave transmissions or are one way transmissions.

was involved, the principal advantage of CTP's approach, certainty of protection for fixed microwave users, would remain.

Additional testing still has to be done. However, CTP believes the Commission should treat interference sensing as an eminently workable approach which merely has to be fine tuned regarding such issues as best FDD solution and application to all radio modulation technologies. For these reasons, CTP believes that these interference sensing should be incorporated into the Commission's analysis of spectrum needs for emerging PCS technologies in this proceeding.

II. ISCDMA does not add Cost or Complexity.

In 1990, CTP initially applied interference sensing to CT2. Existing capabilities of the CT2 technology were adapted for that purpose at no increase in complexity or cost. The control channels set up to transform CT2 to CT2 Plus were used. Similarly, co-channel interference sensing built into CT2 was used to sense microwave interference. The result was an elegantly simple solution to frequency sharing of CT2 with fixed microwave.

The same is true for interference sensing for CDMA (*i.e.*, ISCDMA). Attached Exhibit 1 sets out an approach which adds very little if anything to the cost or complexity of Qualcomm's technology. The same appears to be true for Bellcore's TDMA approach. The basic technology set out in Bellcore's FA of June 1992 is apparently being adapted for interference sensing without significant increase in cost or complexity.

These and other examples from pioneer's preference applicants such as APC and Southwestern Bell demonstrate interference sensing should not be rejected because of perceived additional cost and complexity,[12] and should, moreover, form an important part of the Commission's spectrum accommodation analysis for PCS in this proceeding.

CONCLUSION

As the Commission considers emerging technologies and issues of frequency allocation to accommodate their introduction to the public, CTP feels particular attention should be given to new technologies which allow substantial frequency sharing. There are three general groups of frequency sharing technology which have gained the greatest support: (1) Broadband CDMA, (2) narrow channel TDMA or CDMA where co-existence with fixed microwave is achieved by careful interference mapping of each cell and then excluding PCS channels interfering in any part of the cell; and (3) narrow channel CDMA or TDMA where interference sensing is used to allow automatic, intelligent, frequency agile adjustment to fixed microwave transmissions. The third approach has important advantages. These include increased capacity, certainty of

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[12] For PCS to be widely adopted, costs must also be removed from the network interface. Thus, the approach that should be utilized for integrating PCS into telephone networks is one which realizes economies from providing multiple services, and multiple revenue sources, out of the same telephone network distribution points. Adding PCS alone at distribution points may be economical in many situations. Examples would be substitution for twisted pair in new housing or business developments, or substitution for second lines for data to home or business. However, the economics become much better, and the incremental cost of PCS becomes lower, if PCS network interface costs are shared with costs of providing fiber optic based video on demand and other fiber based services. The same is true for the business user of PCS. CTP has done substantial work on integrating PCS, broadband fiber optics and other fiber optic based services to achieve lower PCS cost. Certain details on CTP's work are provided in attached Exhibit 2.

Also, CTP has been working on the problem of developing a low cost PCS transmission capacity within COAX cable that is being fully utilized by cable TV for TV transmissions. The solution CTP developed with Digidech, Inc. is more fully set out in attached Exhibit 3.

protection for fixed microwave users, regulatory simplicity and, most important, the ability to adjust dynamically to introduction of additional fixed microwave users or to move current microwave paths.

Against these many advantages, the open issues for further ISCDMA testing are few. Accordingly, CTP urges the Commission to incorporate analysis of the capabilities of ISCDMA as it determines spectrum needs and frequency sharing issues for emerging PCS technologies in the 1.8 GHz to 2.2 GHz bands.

Respectfully submitted,

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NARROW CHANNEL FREQUENCY SHARING WITH FIXED MICROWAVE

Purpose. The purpose of this paper is to outline a technical approach to sharing of fixed microwave transmission frequencies with narrow channel direct sequence spread spectrum ("CDMA") for PCS purposes. The CDMA system, which will be referred to as a basis for discussion, is that of QUALCOMM Incorporated.[1] QUALCOMM is a leading developer of CDMA equipment. Its technology has been demonstrated for cellular radio use, and it has filed for a PCS pioneer's preference for its technology (File No. PP-68). In its pioneer's preference filing QUALCOMM states that it believes that by using "hard" handoff (handoff to another channel in the same PCS cell or another cell on a different frequency) and "soft" handoff (handoff to another channel in another cell on the same frequency), and other features of its system, narrow channel (QUALCOMM) CDMA can co-exist on a non-interfering basis with fixed microwave in the 1850 - 1990 MHz band. CTP agrees. In the following sections we will discuss how CTP's interference sensing approach ("ISCDMA") would be applied to the QUALCOMM technology. We will also discuss the further technology testing needed to verify that QUALCOMM's CDMA system can be immediately and widely deployed as ISCDMA PCS throughout the United States.

Background. The general technical characteristics of the QUALCOMM system are as follows:

- Direct Sequence Spread Spectrum Signal (DS-SS).
- Pseudo-Noise (PN) Spreading (Chip) Rate = 1.2288.
- Frequency division duplex (FDD) on paired channels offset 30 to 80 MHz.
- Four forward link channels embedded in each 1.2288 MHz forward transmission channel.
  - Pilot Channel
    1) Unmodulated, low power DS-SS signal. One for each forward transmission channel.
    2) Identifies unique sectors, cells.
    3) Provides nearly perfect phase/time signal strength reference.

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[1]CTP's ISCDMA could also be applied to other manufacturers' narrow channel CDMA systems.

4) Shared among all users in sector/cell and used for acquisition and tracking.

- Sync Channel

  1) Low bit rate (1200 bps) low power DS-SS signal.

  2) Allows immediate synchronization of subscriber terminal to the network.

- Paging Channel(s)

  1) Data rate flexible 2400, 4800 or 9600 bps DS-SS signal(s).

  2) Allows perfect tuning of paging capacity to system needs.

  3) Up to 7 per CDMA transmission channel.

- Traffic Channel(s)

  Data rate flexible 1200, 2400, 4800, or 9600 bps to support variable rate vocoding. Structure in 20 msec frames.

- Two reverse link channels embedded in each 1.228 MHz reverse transmission channel.

  - Access Channel(s)

    1) Used for inbound messaging when not in a call.

    2) Up to 32 per paging channel on reverse transmission.

  - Traffic Channel(s)

    Same configuration as forward traffic channel(s).

- Powerful speech coding based on CELP technology.

  - Compression to 8 Kbps.[2]

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[2]This can be increased if necessary for wireless local loop or other use.

- Idle, soft and hard handoff as described in attachments hereto.

- Use of Rake antennas.

  - Multipath used for gain.

- Very fast and accurate power control.

  - Subscriber terminal measures forward channel power and adjusts reverse channel power accordingly.

  - Base station measures reverse channel power and adjusts forward channel power accordingly.

- Soft cell capacity.

  - Dynamic optimum channel loading with lightly loaded cells contributing less noise and thus allowing busy cells to carry more traffic.

  - Means busy cells produce more summed power than "normal" cells.[3]

- Operates at low power.[4]

  - Average transmit power level of subscriber terminal of less than ten milliwatts.

- CDMA MTSO manages both handoff and channel acquisition.

  - Location of subscriber terminals upon registration.

  - Handoff implementation.[5]

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[3]This will be discussed below in connection with narrow channel CDMA frequency sharing.

[4]An important advantage for CDMA co-existing with fixed microwave. A CDMA channel can exist closer in frequency and geography to a fixed microwave transmission than can a TDMA transmission. This adds capacity in a fixed microwave environment, in addition to the general capacity gain of CDMA over TDMA.

[5]Additional, more detailed information on the QUALCOMM technology and system approach is available in a series of documents published by QUALCOMM.

For the purposes of ISCDMA, call set up is critical. In calling, the subscriber terminal:

- Powers on and performs diagnostic check.
- Scans for a pilot channel.
  - Scan will be for pilot channels in forward transmission channels in frequency order dictated by MTSO.
- Determines whether the pilot channel first found through scan is acceptable.
  - Determination is made based on power level and bit error rate of pilot channel.
- If initial pilot channel unacceptable, subscriber terminal continues scan until acceptable pilot channel found.
- Acquires pilot channel.
- Receives sync channel, receives sync channel message.
- Adjusts to system timing.
- Receives the paging channel, receives overhead information.
- Sends origination message on the access channel.
- Receives channel assignment message on the paging channel.
- Initializes the traffic channel.
- Enters conversation substate.
- Releases call and returns to sync channel.

<u>Frequency Sharing</u>. At the outset, it must be recognized that three problems exist in adapting QUALCOMM's CDMA for ISCDMA frequency sharing. The first is a subscriber terminal problem. It results from the fact the QUALCOMM technology does not have a separate control channel. Without access to a separate control channel which is free of microwave interference throughout the cell site and can be used for initial system acquisition and then the interference sensing process, there is danger a subscriber

terminal would power up and start transmission on a frequency or in an area where the subscriber terminal would cause interference to microwave users.[6] The second problem is a base station and entire system problem. The summed power of the transmission on a channel of a CDMA cell can increase as subscriber demand increases, causing interference to neighboring fixed microwave users, whereas this would not occur in "normal" demand load operation.[7] The third problem is that the QUALCOMM system is an FDD rather than Tine Division Duplexed (TDD) system. This means that non-interfering frequency sharing must be assured for two separate frequency bands (forward and reverse bands) rather than one as in TDD.

A. <u>Subscriber Terminal Interference Sensing.</u>

Possible solutions to the need for subscriber terminal interference sensing before initial transmission are:

- Introduce a separate control channel by making one of the paired QUALCOMM transmission channels primarily a control channel. The MTSO would direct all subscriber terminals to first access this separate control channel upon power on. In each cell, the control channel would be a channel free of microwave interference throughout the cell. Documents filed by CTP with the Commission of the Fall of 1990 spell out in detail how this separate control channel would be used for interference sensing and call set-up. One negative to this separate control channel approach is that the QUALCOMM system would have to be reconfigured as no separate control channel is currently provided. Another negative is that traffic channels are being taken out of voice transmission service;

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[6]CTP's technology gains capacity by being able to use frequencies in a cell site that are free of microwave interference at base station site but interference blocked in some part (but not all) of the cell. This means the subscriber terminal must be able to tell at its particular location that a channel is free though blocked elsewhere in the cell. But scanning to determine interference status must be done before start of transmission or there is danger of creating a short term interference condition before the subscriber terminal can be switched to a non-interfering frequency.

[7]The CTP technical approach, as set out in the CTP/BNR patent application and other documents filed by CTP with the FCC in 1990, assumes that interfering channels at the base station will initially be excluded based on a propagation analysis at the base station site, and then all remaining useable channels scanned regularly to ascertain changes in interference creating need for further channel blockage.

and while data could also be carried on the separate CDMA control channel, some valuable capacity could be lost.

- Have the pilot channels in each cell appear only in connection with those forward transmission channels which are entirely free of microwave interference throughout the entire cell (i.e., pilot channels would be eliminated from forward transmission channels which though free of interference to fixed microwave in some parts of the cell are not free of interference in other parts of the cell). This means that the subscriber terminal on powering on in a cell would find in scanning only a pilot channel for an "approved" forward transmission channel. Interference sensing, as described by CTP, could then take over, using the paging channel; and the subscriber terminal upon scanning for interference could potentially use a transmission channel free at the subscriber terminal site but not free in certain other parts of the cell.[8] The negative to this approach is that it again requires modification of the present QUALCOMM system.

- Use the pilot channels for interference sensing. This most closely corresponds to the way the QUALCOMM system currently works.[9] At the base station site, all interfering transmission channels would be blocked from use. On other channels the pilot channel would be transmitted. The subscriber unit on power on first scans for a pilot

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[8]As described in the documents filed by CTP and Northern Telecom with FCC in October 1990 in Gen. Docket 90-314, a list of free channels at the base station site would be transmitted on the control channel (paging channel in QUALCOMM's case) and scanned for interference at the subscriber terminal site. The cell would then be set up on a channel found to be free of interference at both subscriber terminal and base station.

[9]It will be noted that CTP developed the interference sensing approach for CT2 with BNR by adapting existing features of the technology. In the case of CT2, BNR was introducing control channels for two way CT2 calling in public use and other benefits. Using these control channels and the integral capability of CT2 to sense for co-channel and adjacent channel interference, the technology was easily adapted for interference sensing of fixed microwave transmissions. Similarly, while any of the three proposals here advanced for interference sensing CDMA would work, CTP likes best an approach which takes maximum advantage of existing capabilities of the technology, thereby saving complexity and cost.

channel on a forward transmission channel. If the pilot channel it first scans has low power or exhibits bit error transmission problems, the subscriber terminal continues the scan until it finds a pilot channel with strong power and low bit error rate.[10]

In a fixed microwave environment, microwave interference would cause substantial pilot channel signal degradation. The pilot channel operates at very low power and quickly becomes indecipherable to the subscriber terminal in conditions of a low degree of microwave interference. This means that if the subscriber terminal powered on, scanned a pilot channel which at base station site was free of interference, found that because of fixed microwave interference at the subscriber terminal site that the pilot channel was unusable, the subscriber terminal would reject the channel and continue the scan. Correspondingly, if a particular forward transmission channel is free at some parts of the cell (including the base station) but not others, and if the subscriber terminal is in a free zone, upon power on the subscriber terminal would find the pilot channel; and the transmission channel would become a useable channel by the subscriber terminal, despite the fact it might be an interfering channel if used in certain other parts of the cell. The result would be in accordance with CTP's ISCDMA approach with an increase in cell site capacity.[11] Pilot channel interference sensing would also be used if a subscriber terminal moved within a cell from an interference free zone to one where interference to and from fixed microwave was possible. Under these circumstances, degradation of the pilot channel would occur and hard or soft handoff initiated.[12]

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[10]The specific parameters for pilot channel strength measurement are proprietary to QUALCOMM.

[11]It will be noted that this process is described in the technology discussion produced in September 1990, submitted to the FCC in October 1990, though there applied to CT2 Plus. The subscriber terminal, as there described upon power up scans for control channels and chooses the best channel on which to register and commence transmission.

[12]In idle mode (subscriber terminal on but no traffic transmission) and in transmission mode, the subscriber terminal constantly searches for the strongest pilot channel. Idle handoff occurs when the subscriber terminal finds a stronger pilot channel, and idle handoff occurs to the forward transmission channel which has the strongest pilot channel. Similarly hard and soft handoff is made to the transmission channel with the strongest pilot channel. This gives an extra margin of protection to the fixed microwave